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Public Awareness, Perception, Policy Implementation, and Technological Interventions in Air Pollution Management: A Case Study on Dwarka Circle and Gangapur Road, Nashik.

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Abstract:
Air pollution in urban areas has become an increasingly pressing issue, affecting public health and the environment. This study investigates public awareness, perception, policy implementation, and the role of technological interventions in managing air pollution in two major hotspots in Nashik: Dwarka Circle and Gangapur Road. A mixed-method approach was employed, using survey responses from 355 residents and a semi-structured interview with a Nashik Municipal Corporation official. Quantitative analysis using chi-square tests and regression modeling revealed a significant association between public perception and residential location, while awareness and policy effectiveness emerged as strong predictors of public concern. The study found that although citizens are aware of pollution's causes and impacts, there is limited understanding of government initiatives. Technological interventions such as real-time monitoring and smart infrastructure are perceived as necessary but not fully implemented or trusted. The findings emphasize the need for enhanced environmental education, stronger policy enforcement, and participatory governance to address urban air quality challenges.

Keywords: Urban Air Pollution**,** Public Awareness**,** Public Perception, Policy Implementation**,** Technological Interventions**,** Air Quality Index (AQI)**,** Environmental Governance

1. INTRODUCTION:

Nashik's air pollution remains a persistent concern, marked by significant seasonal spikes that often reach harmful levels. According to data from aqi.in, the city's Air Quality Index (AQI) has risen from 82 in 2020 to 117 in 2025, highlighting a growing and alarming trend that calls for urgent attention. Rapid urbanization and vehicular growth in cities like Nashik have intensified air pollution challenges, significantly impacting public health, environmental sustainability, and overall quality of life. Understanding the level of public awareness and perception regarding air pollution is crucial to designing effective interventions and encouraging community participation in mitigation efforts. Evaluating public opinion on existing government policies and technological interventions can provide critical insights into the effectiveness and gaps in current air quality management strategies. Focus on Key Urban Hotspots like Dwarka Circle and Gangapur Road, two of Nashik's busiest and most pollution-prone areas, serve as critical case study sites to investigate the interconnected roles of awareness, perception, policy, and technology in tackling urban air pollution.

2. LITERATURE REVIEW:

The study titled *"Seasonal Analysis of Particulate Matter and Its Exposure on Urban Bikers in Nashik City, India"* explores the concentration and seasonal variation of particulate matter (PM1, PM2.5, PM10) on seven major highway routes using mobile air quality monitoring mounted on bikes to measure real-time exposure of bikers during peak hours. The introduction highlights the growing concern of traffic-related air pollution, particularly affecting bikers in Indian urban settings. The objective is to quantify personal exposure using Respiratory Deposition Doses (RDDs) and assess the effect of seasons and particle sizes on lung deposition. Using low-cost ATMOS sensors across three seasons (summer, monsoon, winter), the researchers collected data over 5,025 km and applied ICRP equations to calculate RDDs for different lung regions. The results show that winter mornings presented the highest exposure levels, particularly on longer routes like R3 and R5, due to both higher PM concentrations and longer travel times. The conclusion emphasizes that winter poses the greatest risk, monsoon the least, and PM2.5 is most responsible for deep lung deposition, suggesting protective measures like masks and alternate routes to reduce biker exposure.

The study titled *"Perceptions of School Students Regarding Air Pollution"* investigates how sixth-grade students in Aurangabad perceive air pollution, its causes, and their role in combating it. The introduction outlines the growing global and local threat of air pollution, especially among vulnerable populations like children, and emphasizes the importance of environmental education. The literature review highlights national and international findings on students' environmental awareness, noting variations by gender, geography, and education systems, and identifies a gap in localized studies for Maharashtra. The study employed a structured questionnaire administered to 510 students across ten schools using a cross-sectional design, with analysis via SPSS. Findings revealed a general awareness of air pollution and its health impacts, with vehicular emissions identified as the primary cause; however, only 52% knew about AQI, showing gaps in technical knowledge. The conclusion stresses the need for improved environmental communication through school curricula, especially in Marathi-medium schools, and recognizes students' willingness to participate in pollution control as a positive foundation for long-term change.

The paper titled *"Public Awareness and Support for Environmental Protection—A Focus on Air Pollution in Peninsular Malaysia"* by Chin et al., investigates public perception, awareness, and willingness to support environmental protection in relation to air pollution in Malaysia's Klang Valley and Iskandar Malaysia regions, two rapidly urbanizing and industrializing zones. The introduction outlines Malaysia's air quality challenges due to motor vehicle emissions and transboundary haze, framing the study's objective of assessing how Malaysians perceive air quality, their awareness of its health impacts, and their willingness to act or pay for environmental protection. A cross-sectional online survey, designed in English and Malay, gathered responses from 214 Malaysian residents using structured questions based on the Theory of Planned Behaviour, with analysis conducted through SPSS. Findings revealed that while most respondents viewed local air as "somewhat polluted but harmless," those with children or respiratory-illness-affected family members perceived greater risk and showed higher willingness to pay (WTP). Although vehicle emissions were widely recognized as the main source of pollution, preference for private transport remained high. Respondents supported environmental protection in principle but showed limited enthusiasm for personal sacrifice unless collective effort or government transparency was guaranteed. The study concludes that enhancing perceived behavioral control, promoting environmental education, and

building public trust in governance are essential to strengthening support for air quality initiatives in Malaysia.

The study "*People, Place and Pollution: Investigating Relationships Between Air Quality Perceptions, Health Concerns, Exposure, and Individual- and Area-Level Characteristics"* by Tony G. Reames and Mercedes A. Bravo, investigates the complex relationships between perceived air quality, health concerns, and actual exposure to pollutants (PM2.5 and O3) in the Kansas City metropolitan area, using 2,869 survey responses from 2009 to 2012 combined with air quality and socioeconomic data. The paper emphasizes that while air pollution is a documented health risk, public perceptions and concern often differ from measured pollution levels and are shaped by individual demographics and neighbourhood characteristics such as poverty and racial segregation. The research aims to map spatial patterns of exposure, understand socio-environmental influences on perceptions, and examine the extent to which personal and regional factors explain health concerns related to pollution. Using GIS analysis, multivariate linear regression, and ordered logistic regression, the study found inverse patterns between PM2.5 and O3 concentrations and similarly inverse spatial patterns between perceived pollution worsening and health concerns. It also reveals that individual characteristics like age, gender, race, and knowledge of ozone alerts significantly influenced perception and concern, while area-level indicators like poverty and racial isolation were closely tied to PM2.5 exposure and concern about health. The study concludes that public awareness campaigns must be tailored to address these differences in exposure and perception, especially among vulnerable populations, rather than assuming uniform responses to pollution alerts and risk communication.

The study titled *"How Do People Understand Urban Air Pollution? Exploring Citizens' Perception on Air Quality, Its Causes and Impacts in Colombian Cities"* by Omar Ramírez et al, explores citizens' perceptions of urban air pollution, including its causes and impacts, across various Colombian cities, with a focus on the sociocultural dimension often overlooked in environmental policy. A structured online questionnaire was administered to 994 distance-learning students from environmental programs, ensuring a geographically diverse sample, and data were analyzed using logistic regression and chi-square tests. The paper finds that while most respondents rate air quality as poor or fair, and identify particulate matter (PM) as the major pollutant, perceptions differ by city size—larger cities show stronger concern about pollution and its health effects, especially respiratory illnesses. Interestingly, demographic factors like age, gender, and socioeconomic status had no statistically significant impact on perception, but city size did. Participants also recognized households and roadsides as major exposure sites, with vehicular traffic and local industrial sources cited as main contributors. The study concludes that public perception can serve as a useful proxy in cities lacking official air quality data and highlights the importance of integrating public views in designing effective environmental monitoring and policy interventions.

The paper titled *"Public Perceptions of Urban Air Pollution Risks"* examines how individuals and communities understand and respond to the risks of air pollution, particularly in developing countries, using a Pressure–State–Response (PSR) framework. The study's objective is to bridge the gap in literature regarding public perception of urban air pollution, especially how it influences policy-making, community action, and livelihood concerns. It reviews historical and contemporary research, revealing that while people are generally aware of air pollution, their perceptions are shaped more by visible, sensory, and local experiences than by scientific data, and are often influenced by socioeconomic status, media, and cultural context. The methodology is a comprehensive qualitative review of international studies spanning decades, categorized under PSR themes such as perceived pollution sources, health impacts, and responses

to government interventions. Findings highlight discrepancies between measured pollution levels and public perception, limited trust in official information, and resistance to regulatory measures perceived as threats to livelihoods. The paper concludes by identifying significant research gaps, especially the need for context-sensitive, interdisciplinary, and participatory approaches to better understand and integrate public perceptions into effective air quality governance.

3. RESEARCH GAP:

- Mismatch Between Measured Air Quality and Public Perception
- Lack of Area-Specific Perception Studies in Mid-Tier Indian Cities
- Limited Evaluation of Public Understanding of Government Policies and Technological Measures

4. OBJECTIVE OF THE STUDY:

1. To study public awareness regarding causes and impacts of air pollution at Dwarka Circle and Gangapur Road, Nashik.
2. To understand public perception, government policy implementation, and evaluate the role of technology and infrastructure in managing air pollution.
3. To study how Awareness, Perception, Policy Implementation, and Technology Measures predict Public Perception of Air Pollution Impact.

5. RESEARCH METHODOLOGY

Research Type	**Quantitative and Qualitative**
Scope of Research	This study focuses on public awareness, perception, policy interventions, and technology interventions in managing air pollution at Dwarka Circle and Gangapur Road in Nashik.
Primary Data sources	Survey and Personal Interview
Secondary Data sources	Research Papers, Articles, Government Official websites
Sample Size	355
Sampling Techniques	Convenience Sampling Technique
Tools for data Analysis	IBM SPSS Statistics 20

6.HYPOTHESIS:

- **H_{01}:** There is no significant awareness among residents regarding causes of air pollution at Dwarka Circle and Gangapur Road.

- **H_{02}:** Public perception does not consider air pollution to have a significant impact on health and daily activities.
- **H_{03}:** Residents perceive that policy measures by the government are effective in controlling air pollution.
- **H_{04}:** Technological interventions and infrastructural developments are not perceived as significant solutions by the public.

7. VARIABLES UNDER THE STUDY:

1. Public Awareness and Residential Location
2. Public Perception and Residential Location
3. Technological Interventions and Residential Location

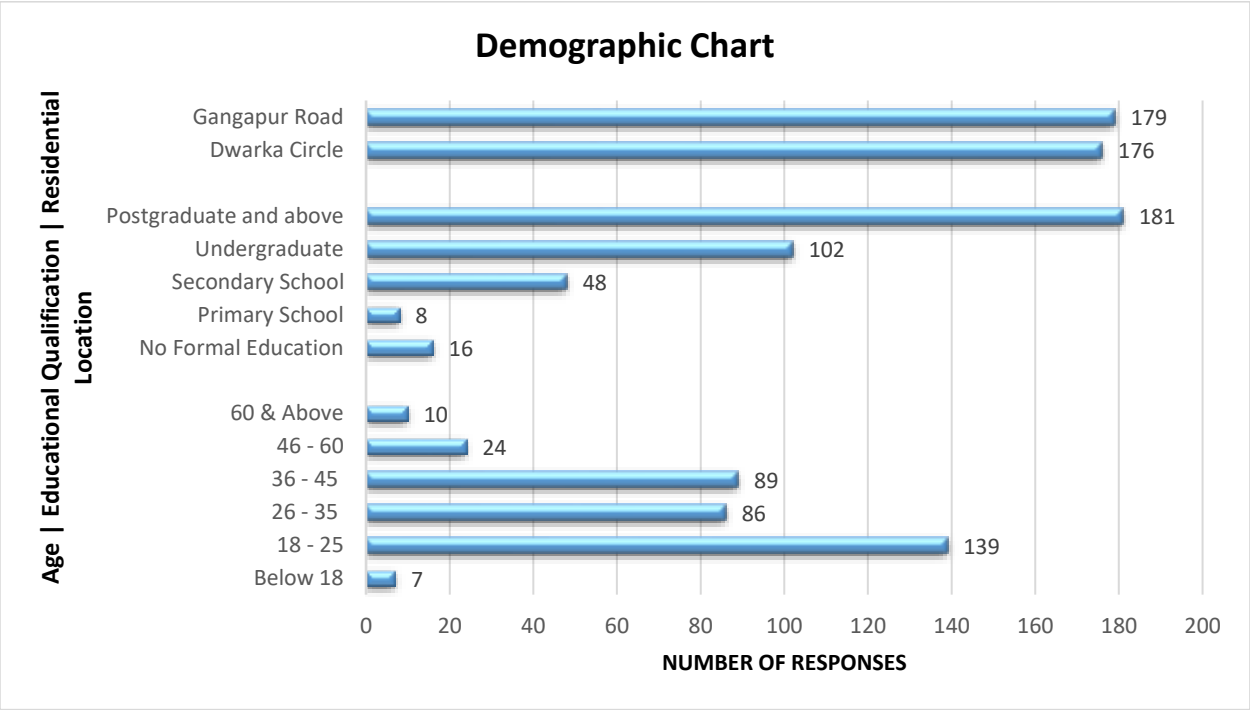
8. RESEARCH TOOLS:

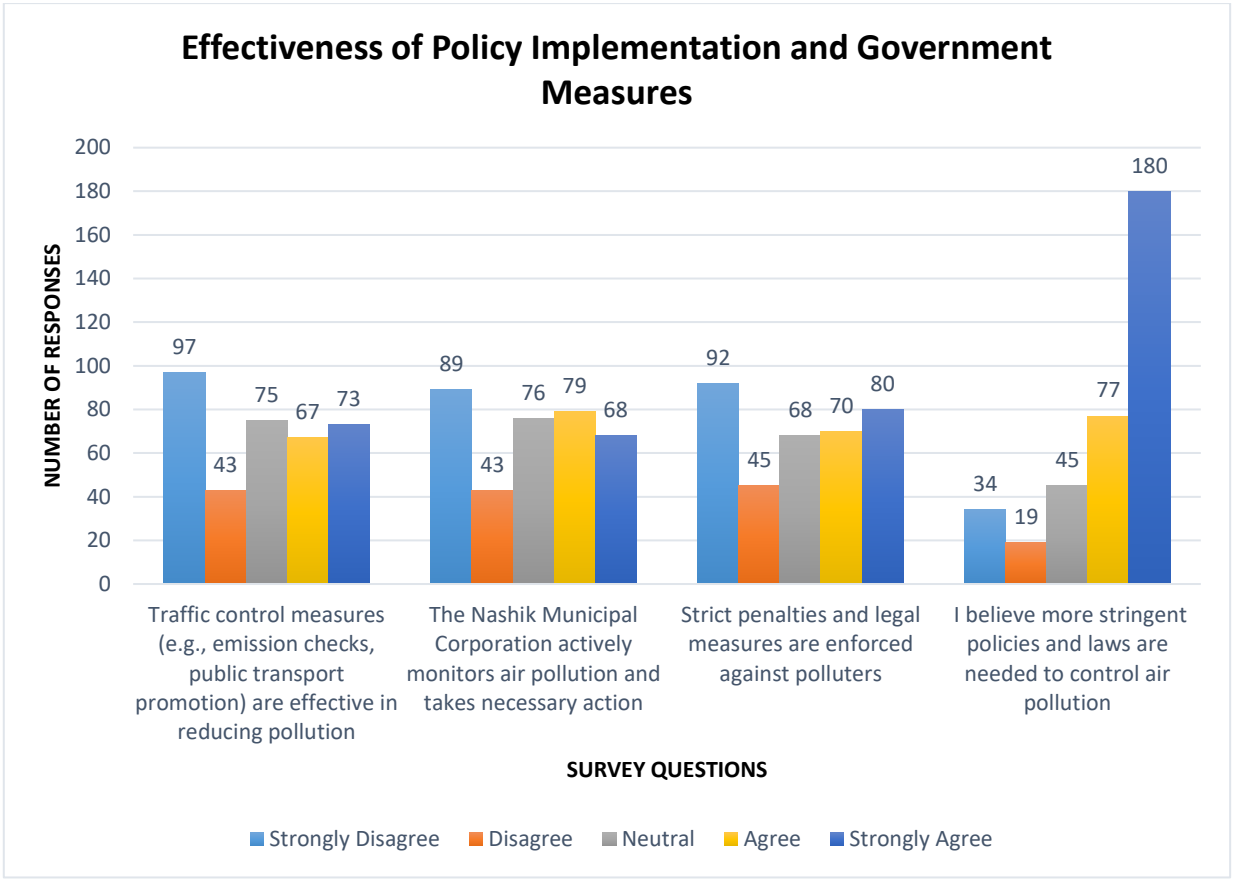
For the purpose of the study,
Primary data was collected by designing a Questionnaire considering:

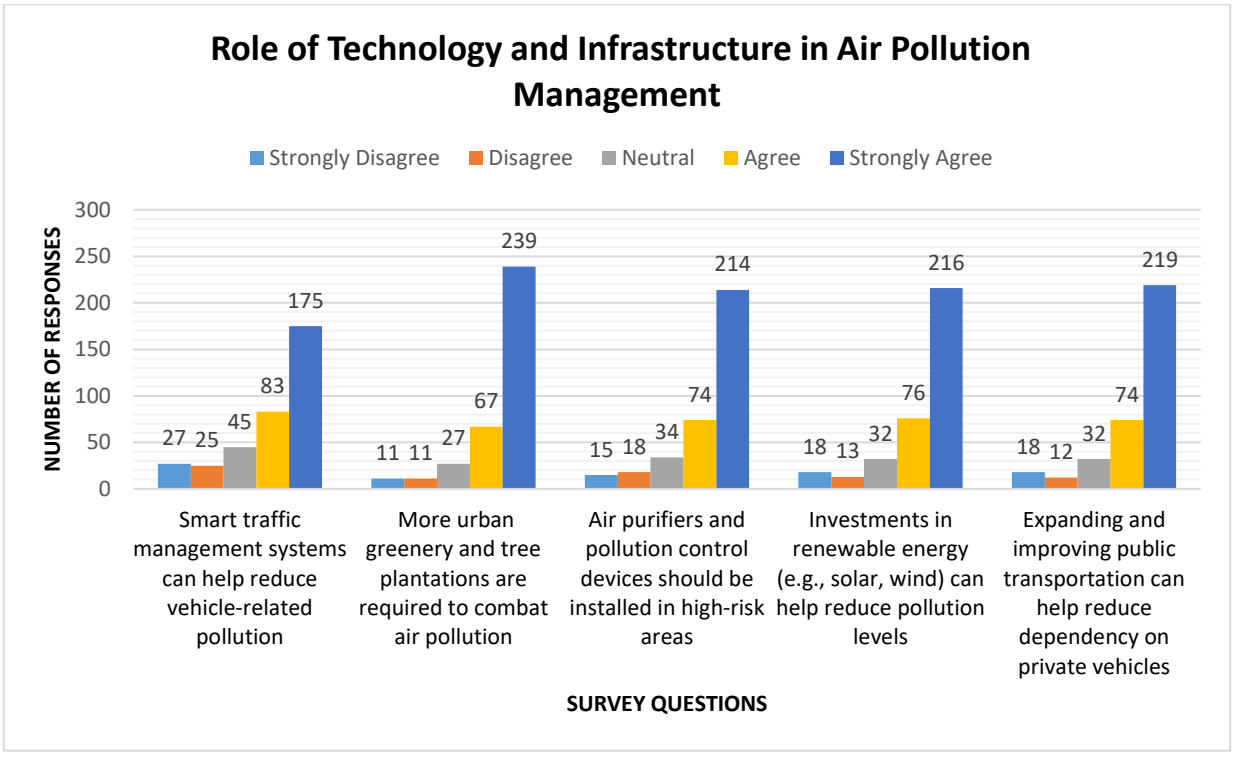
- Structured Questions
- Demographic Questions
- Likert Scale Questions

To support the secondary data, a semi-structured interview was conducted with an official from the Nashik Municipal Corporation (NMC) to understand the city's air quality monitoring practices and policy interventions.
Date: 04/03/2025 | Time: 4PM – 5PM | Location: NMC, Nashik | Name of the Official: Mr. Rahul Bobe| Department: Paryavaran Vibhag.

9. DATA ANALYSIS AND INTERPRETATION




Effectiveness of Policy Implementation and Government Measures
NUMBER OF RESPONSES
200
180
160
140
120
100
80
60
40
20
0
97
43
75
67
73
89
43
76
79
68
92
45
68
70
80
34
19
45
77
180
Traffic control measures (e.g., emission checks, public transport promotion) are effective in reducing pollution
The Nashik Municipal Corporation actively monitors air pollution and takes necessary action
Strict penalties and legal measures are enforced against polluters
I believe more stringent policies and laws are needed to control air pollution
SURVEY QUESTIONS
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


Role of Technology and Infrastructure in Air Pollution Management
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree
NUMBER OF RESPONSES
300
250
200
150
100
50
0
27 25 45 83 175
11 11 27 67 239
15 18 34 74 214
18 13 32 76 216
18 12 32 74 219
Smart traffic management systems can help reduce vehicle-related pollution
More urban greenery and tree plantations are required to combat air pollution
Air purifiers and pollution control devices should be installed in high-risk areas
Investments in renewable energy (e.g., solar, wind) can help reduce pollution levels
Expanding and improving public transportation can help reduce dependency on private vehicles
SURVEY QUESTIONS

1. To study public awareness regarding causes and impacts of air pollution on health and daily activities.
H_{01}: There is no significant awareness among residents regarding causes of air pollution at Dwarka Circle and Gangapur Road. (REJECTED)
H_{11}: There is significant awareness among residents regarding causes of air pollution.

Variable 1	Variable 2	Chi-Square Value	df	p-value	Interpretation
Awareness of Causes	Residential Location	5.32	1	0.021	Significant Association

Here the p = 0.021 (less than 0.05) that means, there is significant awareness among residents regarding causes of air pollution at Dwarka Circle and Gangapur Road

2. To understand public perception, government policy implementation, and evaluate the role of technology and infrastructure in managing air pollution.
H_{02}: Public perception does not consider air pollution to have a significant impact on health and daily activities. (REJECTED)

Variable 1	Variable 2	Chi- Square Value	df	p-value	Interpretation
Residential Location	Public Perception	6.512	2	0.039	Significant Association

p = 0.039 (less than 0.05) that means there is a significant association between Residential Location and of air pollution at 5% significance level.
H_{03}: Residents perceive that policy measures by the government are not effective in controlling air pollution. (REJECTED)
H_{13}: Residents perceive that policy measures are insufficient or ineffective.

Variable 1	Variable 2	Chi- Square Value	df	p-value	Interpretation
Residential Location	Government Policy Effectiveness	7.203	2	0.027	Significant Association

p = 0.027 (less than 0.05) that there is a significant association between Residential Location and perception of Government Policy Effectiveness.
H_{04}: Technological interventions and infrastructural developments are not perceived as significant solutions by the public. (REJECTED)

Variable 1	Variable 2	Chi-square Value	df	p-value	Interpretation
Technological Interventions	Infrastructural Developments	5.768	2	0.049	Significant Association

p = 0.049 that there is a significant association between Residential Location and perception of Technological Interventions at 5% significance.

3. To study how Awareness, Perception, Policy Implementation, and Technology Measures predict Public Perception of Air Pollution Impact.

Multiple Regression:

Dependent Variable (Y):

- Public Perception of Air Pollution Impact

Independent Variables (X):

- Awareness
- Policy Implementation
- Role of Technology

MODEL,

$Y=\beta_0 +\beta_1$ (Awareness)$+\beta_2$ (Policy Effectiveness) $+\beta$ 3 (Technology Measures) $+\epsilon$

Public Perception=1.20+0.50(Awareness)+0.35(Policy Effectiveness) +0.25(Technology Measures)

Model Summary

$R = 0.775$ $R^2 = 0.601$

Adjusted $R^2 = 0.562$

Std. Error = 0.395

Interpretation:

- The **R^2 value of 0.601** indicates that 60.1% of the variance in *Public Perception* is explained by the combined effect of *Awareness*, *Policy Effectiveness*, and *Technology Measures*.
- The **Adjusted R^2 value (0.562)** accounts for the number of predictors and indicates a moderately strong model fit.
- The standard error of 0.395 suggests the average deviation of the predicted values from the actual values.

ANOVA Table:

Source	F	p-value
Regression Model	15.230	0.000

Interpretation:

The model is **statistically significant** ($F = 15.230$, $p < 0.05$), indicating that the independent variables together significantly predict the dependent variable (Public Perception).

Beta Coefficient Interpretation

- All independent variables (Awareness, Policy Effectiveness, Technology Measures) have a **statistically significant effect** on Public Perception ($p < 0.05$).
- Among them, **Awareness has the highest standardized Beta coefficient**, indicating it has the **strongest impact** on shaping public perception compared to the other predictors.

10. FINDINGS

1. A majority of respondents were aware of the causes and health impacts of air pollution, but awareness about the Air Quality Index (AQI) and government policies was moderate.
2. Vehicular emissions were identified as the primary cause of air pollution at Dwarka Circle and Gangapur Road, followed by burning of waste.

3. Most respondents agreed that air pollution has increased over the years and negatively impacts daily activities and public health, especially for children and elderly individuals.
4. Public perception indicated that current pollution control and monitoring measures by the government are perceived as insufficient, with a demand for stricter laws and enforcement.
5. Respondents strongly favored technological interventions such as smart traffic management systems, urban greenery, installation of air purifiers, and improvements in public transportation to manage air pollution.
6. Insights from NMC Official:

Policies and Regulatory Measure

- The NMC official highlighted that Nashik follows the National Clean Air Programme (NCAP), implemented in coordination with ministries like MOHUA, MORTH, and MNRE. Measures include promotion of green transport, adoption of BS-VI emission norms, and a vehicle scrappage policy to reduce vehicular pollution. Additionally, solid waste regulations penalize violators of plastic and construction debris norms—₹5,000 to ₹20,000 fines and up to 6 months' imprisonment for repeated offenses related to single-use plastics.
- **Challenges in Implementation:** Enforcing air pollution control faces hurdles such as increased construction, open burning of solid waste, and continued reliance on private vehicles despite the availability of public transport. The official stressed the need for behavior change among citizens.
- **Technological Interventions:** The Maharashtra Pollution Control Board (MPCB) has installed Continuous Ambient Air Quality Monitoring Stations (CAAQMS) across Nashik. As of 2022, four mobile CAAQMS units were set up at key points, including Dwarka Circle and Gangapur Road. These provide real-time data, supplementing the National Air Monitoring Programme (NAMP), under which air quality is monitored twice weekly at fixed stations.
- **Coordination with Agencies:** The NMC coordinates actively with MPCB and CPCB under the NCAP framework. MOHUA supports smart urban planning and green infrastructure, while MNRE's promotion of renewables indirectly reduces air pollution from coal-based power sources.

11. CONCLUSION:

The study highlights that while the public in Nashik, particularly in the areas of Dwarka Circle and Gangapur Road, demonstrates a high level of general awareness about the causes and health impacts of air pollution, awareness of specific government policies and regulatory frameworks remains limited. The perception that air quality has deteriorated in recent years is strong, and there is a prevailing belief that existing government measures are inadequate.

Respondents expressed a clear demand for more visible, stringent, and well-communicated policy interventions. Technological and infrastructural solutions—such as smart traffic systems, urban greenery, and the promotion of renewable energy—were widely supported, indicating public readiness to embrace innovation for cleaner air.

By integrating public perception with empirical data analysis, this study contributes to the growing body of environmental research in mid-sized Indian cities and offers actionable insights for urban planners, policymakers, and environmental authorities. Strengthening awareness campaigns and fostering collaborative governance between citizens and municipal bodies are crucial steps toward sustainable air quality management.

12. FUTURE SCOPE FOR RESEARCH:

1. Broaden the study to more areas within Nashik or compare across cities.
2. Conduct long-term studies to track changes in awareness and policy impact.
3. Analyze how awareness leads to behavioral changes like use of public transport.

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